Summary of the Beam Tests with the DESY GEM Module

LCTPC Collaboration Meeting 2020

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Hamburg, 2020-01-14

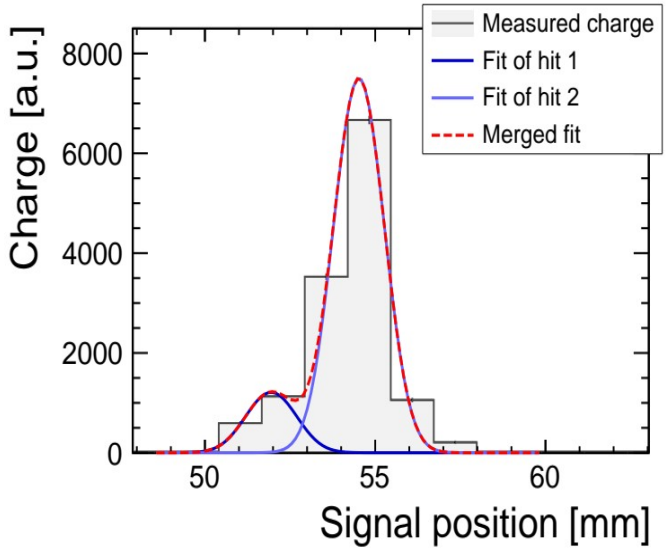
HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

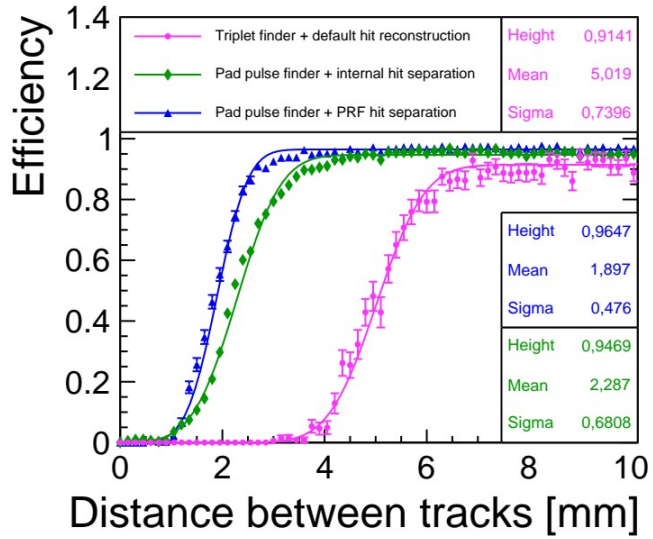
DESY.

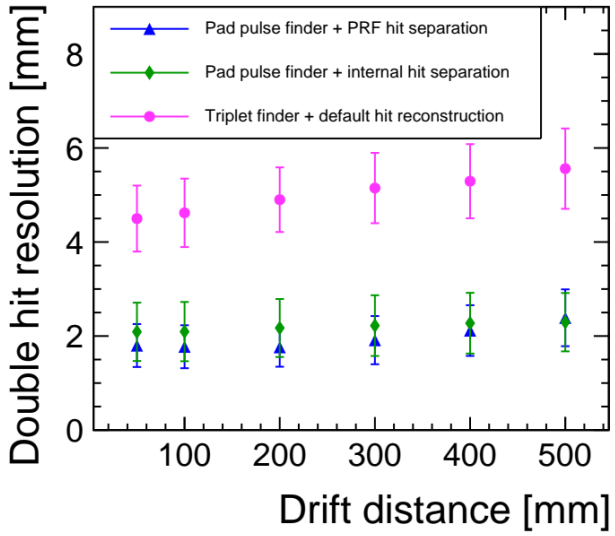
Double Hit Resolution

Analysis by Oleksiy Fedorchuk

- Double track events from runs with 1% X_0 target inside of magnet.
- Default hit reconstruction in MarlinTPC requires at least one empty pad in between hits.
- New combined hit and track finder with integrated hit separation by Claus Kleinwort.
- Independent hit splitting by fitting of double hit structure by Oleksiy Fedorchuk.
- Both methods combined give double hit separation of ~1.9 %.
  - Defined as point of 50 % separation efficiency.



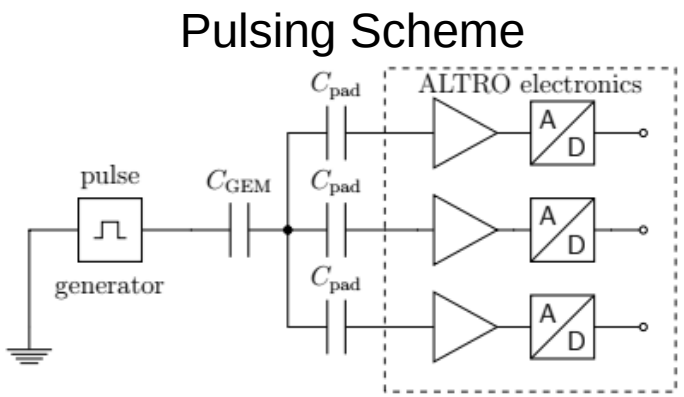


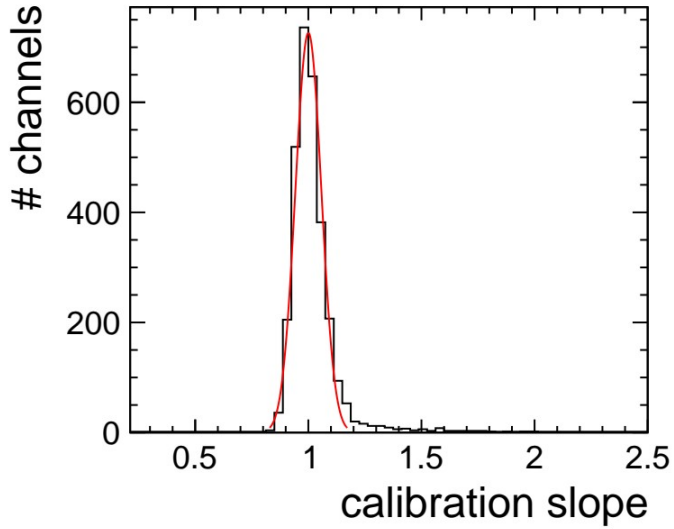


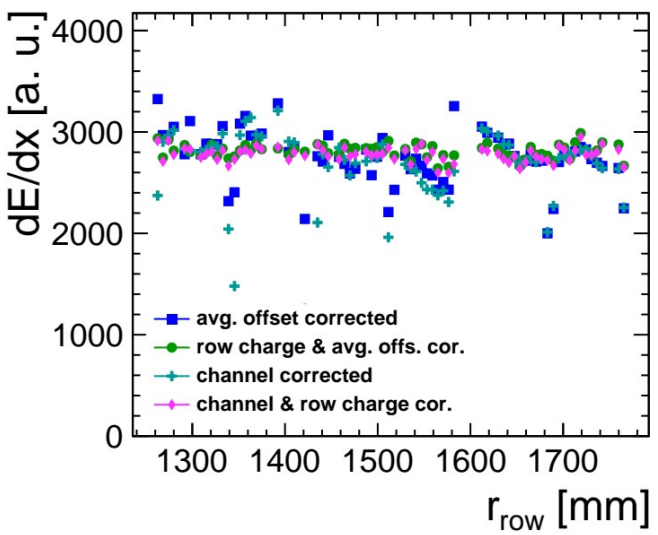
dE/dx Resolution

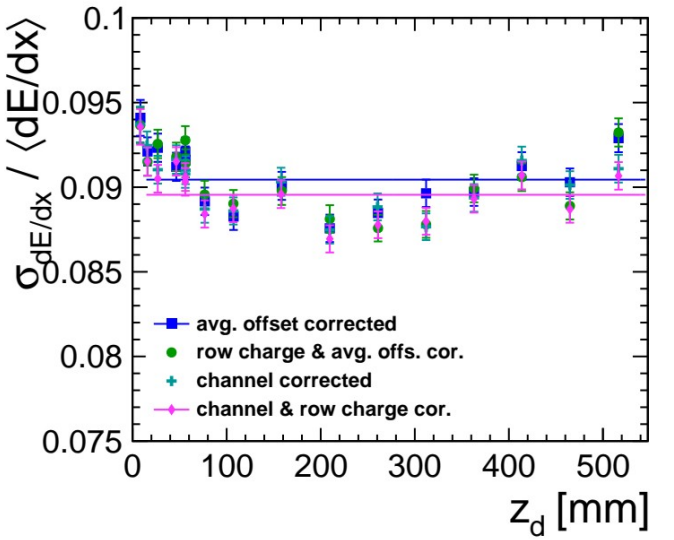
Calibration Attempts

- Channel calibration by pulsing lowest GEM in stack with.
  - Difficult due to protection / loading resistors.
  - Affected by presence of ceramic grids.
- Local gain correction based on average charge on each row.
  - Calculated on subsample of ~1000 events.
- Charge measurement much more homogeneous.
- Only small impact on dE/dx resolution, as expected.





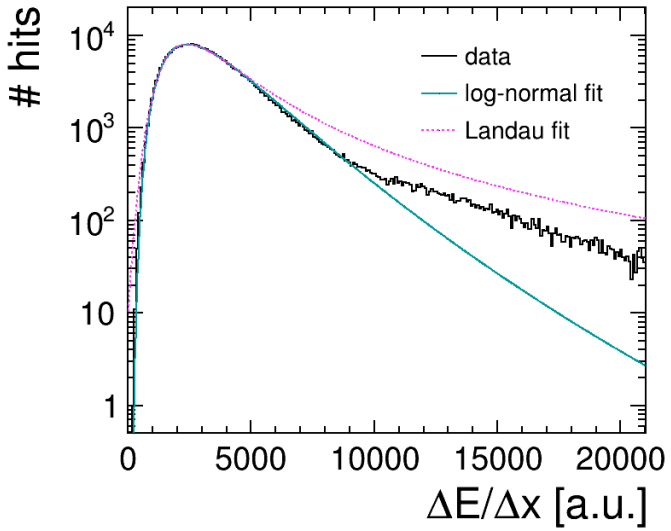


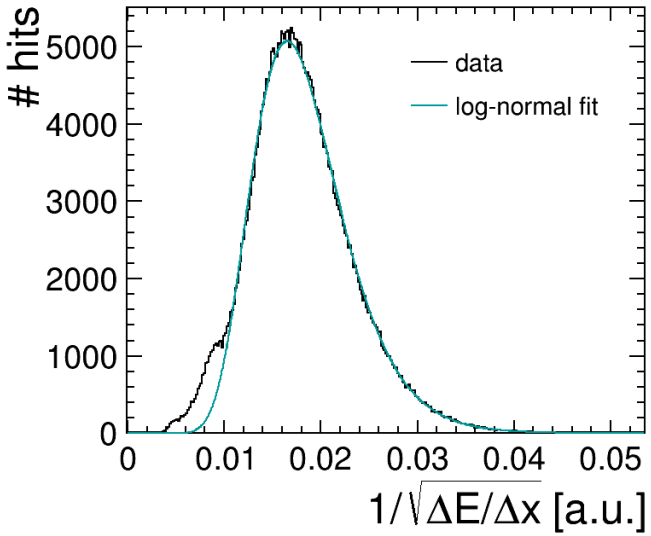


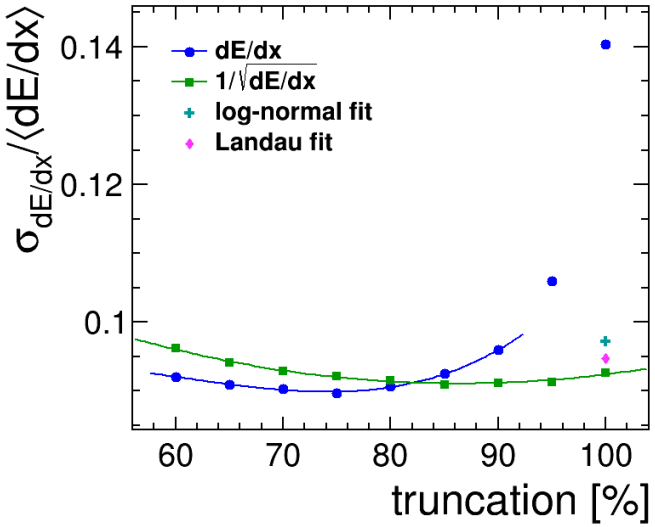
dE/dx Resolution

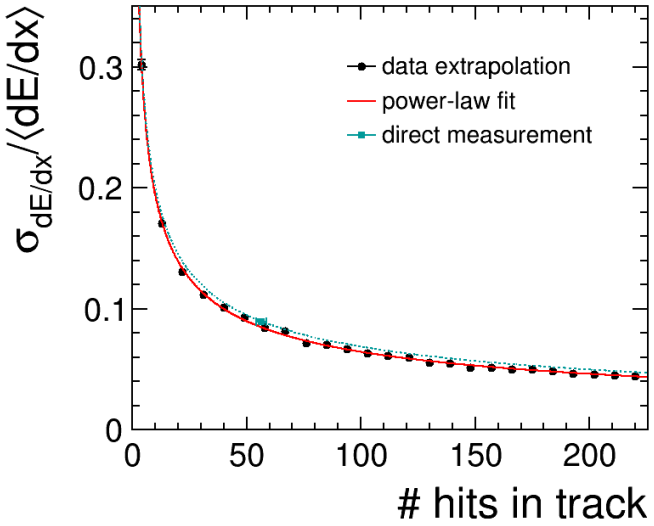
Measurement & Extrapolation

- Optimisation of estimator and truncation fraction.
- Energy loss distribution not fully described by models.
- Resolution with 75 % truncated distribution = (8.96 ± 0.14) %.
- Extrapolation by combining hits from several events.
- Resolution at 220 hits (large ILD) = (4.41 ± 0.02) %.
- Direct measurement with LP slighly underestimated by extrapolation. → Some bias?





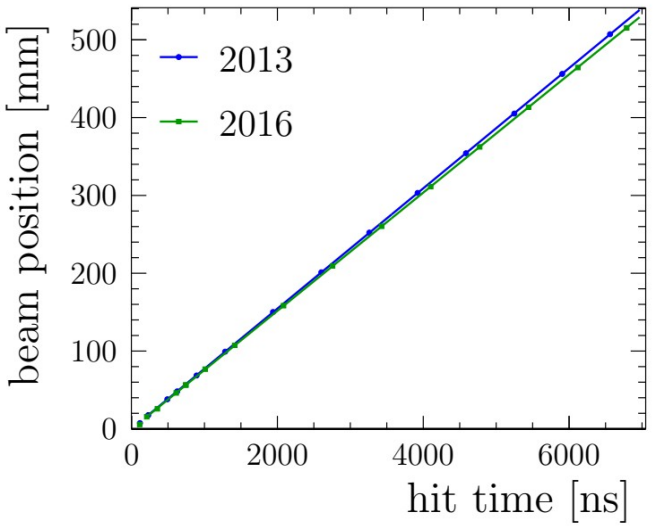


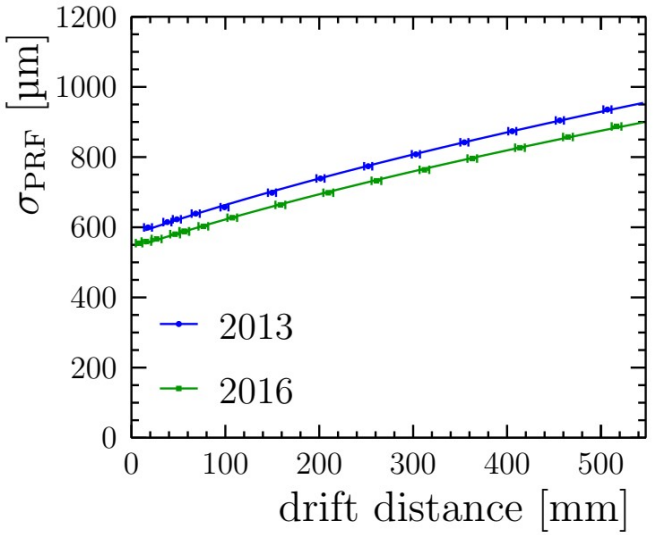


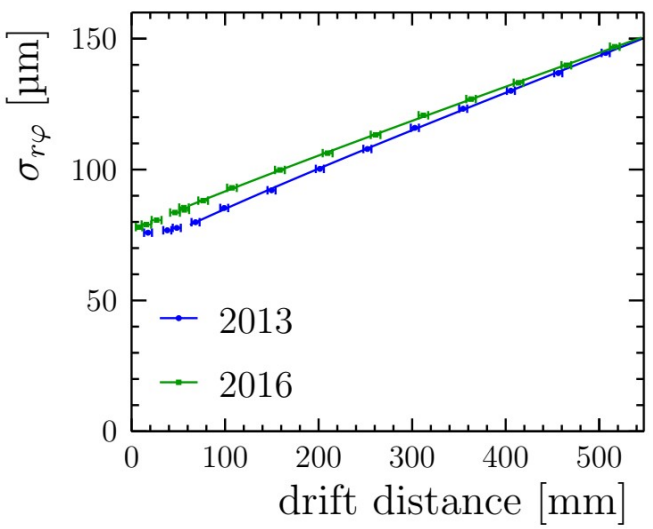
Comparison with earlier Beam Test

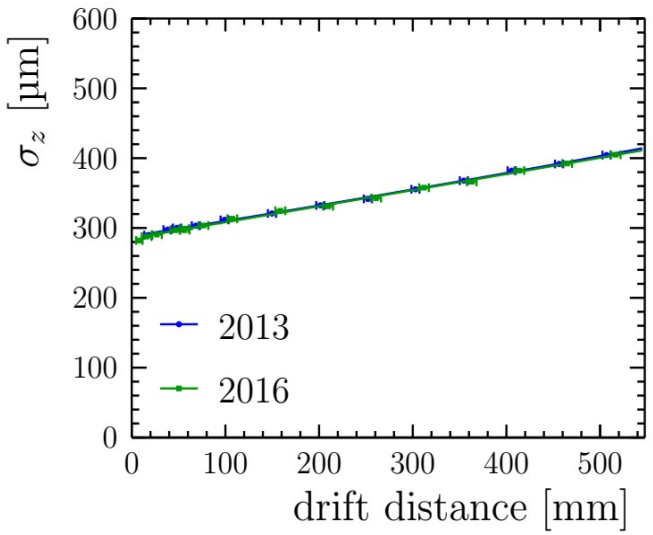
A first look.

- Good compatibility in drift speed, also with simulation.
- Unexpectedly narrower PRF.
- But worse resolution in rφ?!?
  - Maybe s-curve effect due to narrower PRF?
- Perfect match in z-resolution.
- Long investigation of discrepancy:
  - Angular effects.
  - Environmental effects.
  - Gas contamination.
  - HV settings.









Comparison with earlier Beam Test

What's up with the PRF?

- Is the narrower PRF reflected elsewhere?

  → Signal rise time is also shorter in new data!

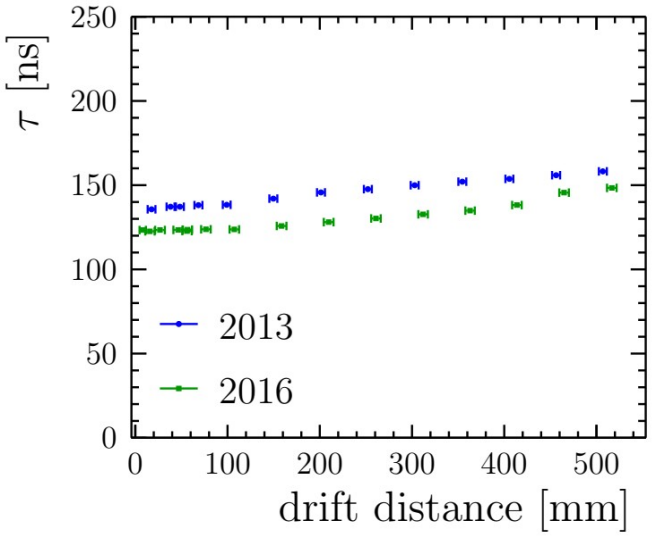
- Compatible with generally lower diffusion within the GEM stack.

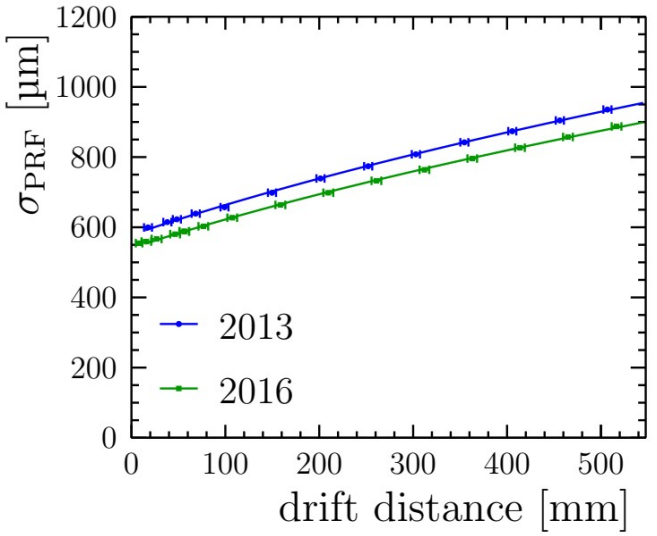
- Could be caused by improved GEM flatness in new modules.

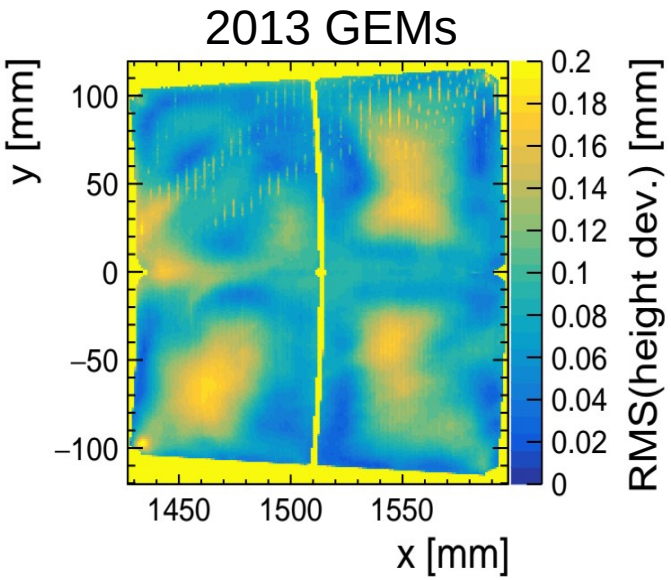
  → Less transverse field components.

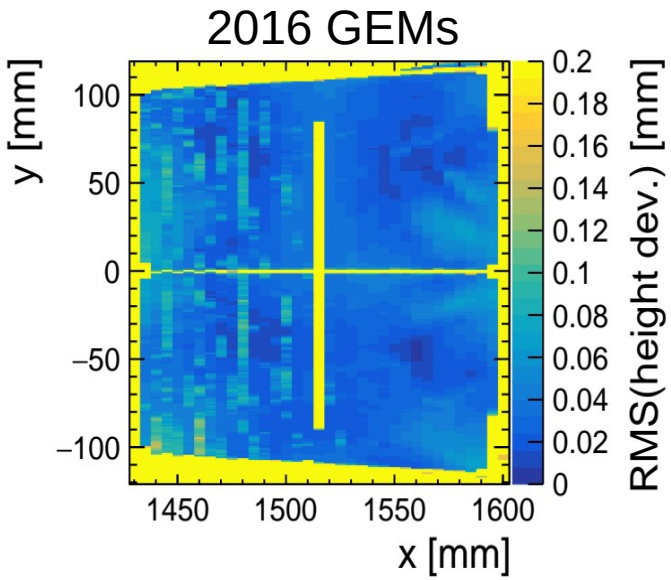
  → Less ExB effects.

- Further investigation needed.









Comparison with earlier Beam Test

A remedy.

- Shorter pulse rise time affects pulse finding efficiency.

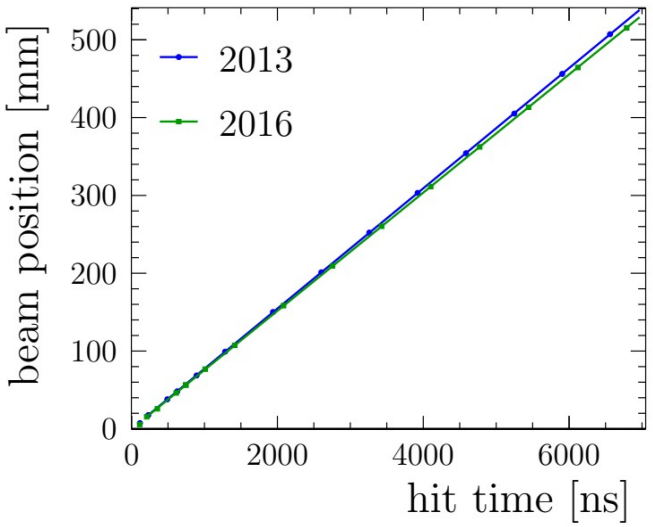
  → Reaching minimum required pulse length harder.

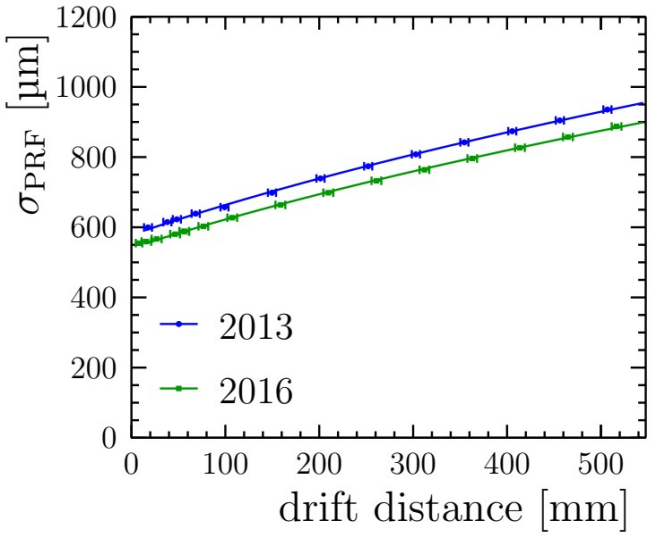
- Therefore process 2016 data with relaxed pulse length requirement.

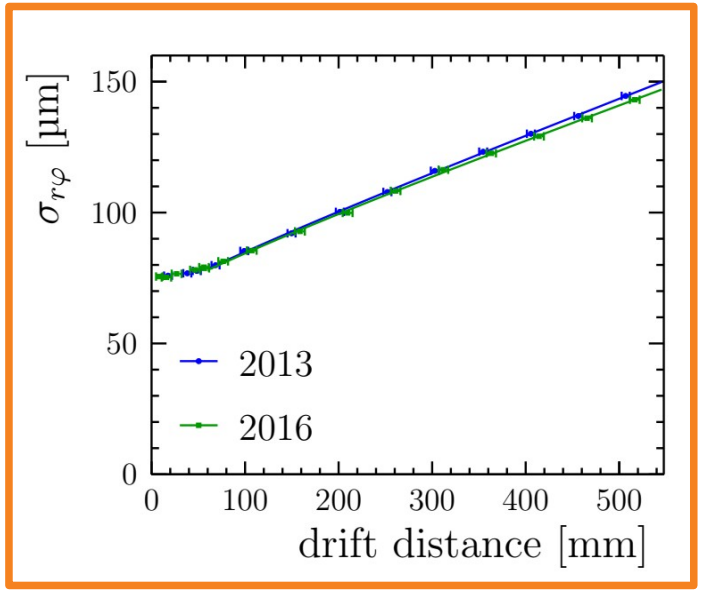
  → 4 instead of 5 samples.

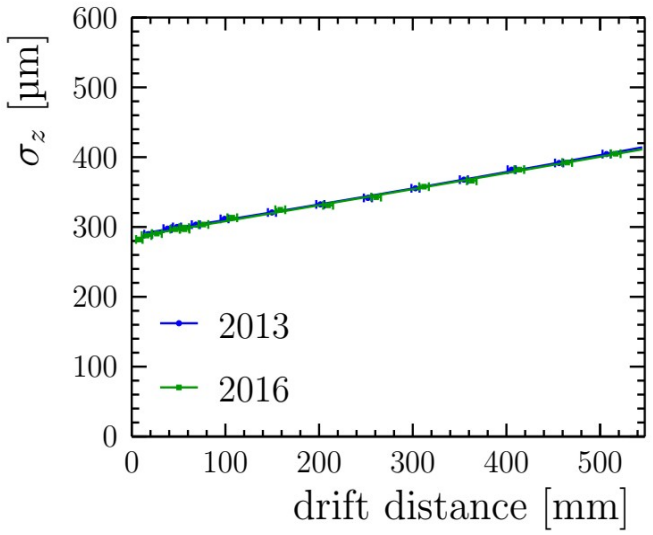
- Recovers rφ-resolution.

- Other parameters unaffected.









Summary

- Two algorithms for double hit separation have been implemented by Oleksiy Fedorchuk and Claus Kleinwort, respectively.
- A double hit resolution below 2 mm has been achieved by combining both.
- Calibration procedures for the charge measurement have been established.
- The dE/dx resolution has been extrapolated to 4.4% for the large ILD TPC.
- A discrepancy between two beam tests has been observed, that is related to the signal size / shape.
- The discrepancy seems compatible with improved field homogeneity in the new modules.
- Taking the signal shape into account, the point resolution measurements of the earlier test could be confirmed.

Thank you

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